

EVAPORATIVE EMISSION FACTORS

MEASURING AND MODELING NON-TAILPIPE HYDROCARBON EMISSIONS

In addition to [exhaust emissions](#), the EMFAC model estimates hydrocarbon losses from evaporation. Evaporative losses are modeled as four separate processes:

1. **Diurnals** are evaporative losses which occur as a result of rising ambient temperature which heats the fuel.
2. **Hot Soaks** occur immediately following vehicle use and can last up to 35 minutes. Fuel heated by the engine and through circulation through the fuel system causes evaporation.
3. **Running Losses** occur while the vehicle is being operated. Running losses include what was historically referred to as "blow-by" or "crankcase" emissions.
4. **Resting Losses** are a result of permeation through the rubber and plastic components of the fuel system. Resting losses are defined as occurring when the vehicle has not been operated for more than 35 minutes (not a hot soak) and the ambient temperature is steady or falling.

Evaporative emissions are collected by placing a vehicle in an air tight enclosure, referred to as a shed, and measuring the hydrocarbons which are released. The test method is referred to as the Sealed Housing Evaporative Determination or SHED testing. The SHED test results of over 1,800 vehicles are included in the current EMFAC model most of which were tested during the periodic [Surveillance Projects](#).

EMFAC EVAPORATIVE DATABASE

Year	ARB	Auto Oil	EPA	CRC
1969	1			
1970	17			
1971	27			
1972	28			
1973	25			
1974	32			
1975	76			
1976	94			
1977	60			
1978	135			
1979	124			
1980	150		1	
1981	127		5	
1982	109		5	
1983	90	16	7	
1984	88	27	7	
1985	61	22	8	
1986	38	33	19	
1987	24	39	16	
1988	20	35	13	
1989	11	26	15	
1990	6	35	14	
1991	4	36	15	
1992	3	26	9	13
1993		4	3	12
1994			8	12
1995				4
1996				6
1997				2



Light-Duty Truck in an Environmentally Controlled Shed

Evaporative Emission Processes

Process	Engine Status	Ambient Temperature	Engine Off >35 mins
Diurnal	OFF	Rising	YES
Hot Soak	OFF	N/A	NO
Running Loss	On	N/A	N/A
Resting Loss	OFF	Stable/Falling	YES

Diurnal and Resting Loss emissions are determined by placing the vehicle in a shed and cycling the temperature over a prescribed profile. The length of the test varies from as little as one hour to as long as three days depending upon the certification standard.

The **Hot Soak** test is performed by placing the vehicle in the shed immediately following the running loss test.

The emissions are measured for one hour although modal (minute by minute) measurements suggest that the event is over after 35 minutes.

The **Running Loss** test is performed on a dynamometer within a shed. Exhaust gases are routed out of the enclosure leaving only evaporative emissions. **Running Loss** emissions are usually collected over a one hour period while the vehicle is driven over three consecutive [LA4 cycles](#) performed at 95°F.

Technology Fractions For Light-Duty Evaporative Emissions

1. < 70 Uncontrolled
2. 70-76 CARB NCAT
3. 75-76 CARB CAT
4. 77+ CARB NCAT
5. 77+ CARB CAT
6. 70-78 TBI
7. 70-78 FI
8. 79-85 TBI
9. 79-85 FI
10. 86-94 TBI
11. 86-94 FI
12. 95+ TBI
13. 95+ FI
14. All Enhanced / OBD
15. All Near Zero / OBD
16. All ZEV
17. All PZEV

CARB = Carbureted

NCAT = Non Catalyst

TBI = Throttle Body Fuel
Injection

FI = Fuel Injection

ZEV = Zero Emission
Vehicle

PZEV = Partial Zero
Emission Vehicle

BASIC EVAPORATIVE EMISSION RATES

Like [Basic Emission Rates](#) for exhaust, the emission rates for evaporative hydrocarbons are based on test data collected primarily in ARB's [Surveillance Projects](#) performed at the [Haagen-Smitt Laboratory](#) in El Monte.

Where [exhaust emissions](#) are stratified into five levels or "Regimes", only three regimes are used in modeling evaporative emissions.

Normal emitters are those vehicles that have properly functioning evaporative control systems.

Vehicles which leak fuel are referred to as "liquid leakers" and are considered **Super emitters**. This distinc-

tion is important in that [On-Board Diagnostics \(OBD\)](#) can not detect liquid leaks.

Moderate emitters are those vehicles who's emission rates fall between Normal and Super emitters. These vehicles have problems that are detectable by OBD such as loose fittings, small holes in hoses and loose gas caps.

As opposed to exhaust emissions, evaporative emissions are modeled as a function of age rather than mileage.

The evaporative emissions inventory is dominated by running losses. While running loss standards are expressed in terms of grams per mile,

EMFAC models running losses as a function of the time that the engine has been operating as a surrogate for fuel temperature. Running loss emission rates for malfunctioning vehicles can be as high as exhaust emission rates.

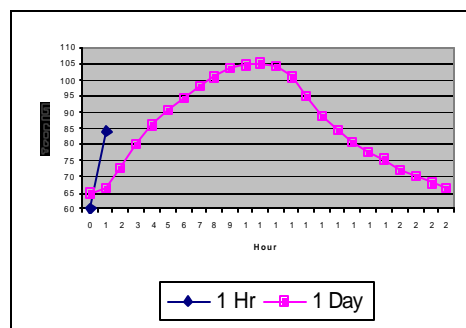
Hot soaks follow running losses in overall magnitude because of the sheer number of trips. Very short trips are modeled as having no associated hot soaks, however.

Diurnals and resting losses follow hot soaks in contribution to the evaporative inventory. These emissions are associated with inactivity and follow the assumption that the passenger cars sit for 23 of the 24 hours in the day.

PASSENGER CAR EVAPORATIVE STANDARDS

Model Years	Diurnal + Hot Soak Standard	Running Loss Standard	Test Procedure	Notes Diurnal/Hot Soak
1970-1971	6.0 grams per test	N/A	Carbon Trap	
1972-1977	2.0 grams per test	N/A	Carbon Trap	
1978-1979	6.0 grams per test	N/A	SHED	1 Hour / 1 Hour
1980-1994	2.0 grams per test	N/A	SHED	1 Hour / 1 Hour
1995-2003	2.0 grams per test	0.5 grams per mile	SHED	3 Day / 1 Hour
2004+	0.5 grams per test	0.5 grams per mile	SHED	3 Day / 1 Hour

DIURNAL TEMPERATURE PROFILES



The one hour diurnal heat build was performed by heating the fuel tank and measuring the temperature rise with a thermocouple threaded through a gas cap. This methodology prevented the detection of faulty gas caps.

The current test procedure requires that the ambient air within the shed to be heated and cooled over the entire day and the vehicle is tested with it's own gas cap.